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# Identifying Industrial Best Practices for the Waste Minimization of Low-Level Radioactive Materials

Prepared for
**U.S. Department of Energy**
**Office of Waste Management**
**Environmental Management**
**Pollution Prevention Division, EM-77**

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## Abstract

In the U.S. Department of Energy (DOE), changing circumstances are affecting the management and disposal of solid, low-level radioactive waste. Limited space in disposal facilities, fewer available disposal facilities, and increasing disposal costs are affecting DOE. From 1977 to 1991, the nuclear power industry achieved major reductions in solid waste disposal. Because of those results, DOE is interested in learning about and applying those practices to reduce solid waste at DOE facilities. The project's focus was to identify and document commercial nuclear industry best practices for radiological control programs supporting routine operations, outages, and decontamination and decommissioning (D&D) activities. The project team, comprised of DOE facility and nuclear power industry representatives, defined a Work Control Process Model, collected nuclear power industry Best Practices (BPs), and made recommendations to minimize low level waste (LLW) at DOE facilities. The team made the following recommendations to improve low level waste minimization efforts: (1) Provide incentives to encourage waste minimization. (2) Management needs to provide resources, communicate with personnel, and establish cross-functional teams to address LLW. (3) Sites need to implement technical criteria for proper disposition of waste based on recent DOE guidelines. (4) Include waste minimization practices in all aspects of the work control process.

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# Acronyms and Terminology

| | |
|---|---|
| Anti-Cs | Anti-contamination clothing (see also PCs) |
| BP | Best Practices |
| BWR | Boiling Water Reactor |
| CCB | Change Control Board |
| CMR | Chemistry and Metallurgy Research Facility |
| DAW | Dry Active Waste |
| DOE | Department of Energy |
| DOE complex | All DOE physical locations, encompassing all sites |
| DOT | Department of Transportation |
| DP | Defense Programs |
| dpm | disintegrations per minute |
| EM | Environmental Management |
| EPA | Environmental Protection Agency |
| EPRI | Electric Power Research Institute |
| ES&H | Environment, Safety and Health |
| Facility | One building or dedicated group of buildings for one major purpose within a site. For example, CMR is a facility at the LANL site. |
| FSS | Facility Safeguards and Security |
| HEPA | High Efficiency Particulate Air |
| HP | Health Physics |
| HPGe | High Purity Germanium |
| INPO | Institute of Nuclear Power Operations |
| LANL | Los Alamos National Laboratory |
| LLD | Lower Limit of Detection |
| LLW | Low Level Waste (solid only) |
| M&E | Materials and Equipment |
| MWe | Megawatts Electric |
| NRC | Nuclear Regulatory Commission |
| ORR | Operational Readiness Review |
| PCs | Protective Clothing |
| PCM | Personal Contamination Monitors |
| PWR | Pressurized Water Reactor |
| QA | Quality Assurance |
| RCA | Radiologically Controlled Area |
| RCRA | Resource Conservation and Recovery Act |
| RWP | Radiation Work Permit |
| Site | A DOE site, for example, LANL, that encompasses several facilities |
| SPA | Single Point of Accountability |
| SWP | Special Work Permit |
| TLD | Thermo-Luminescent Dosimeter |
| TRU | Transuranic |
| TSDF | Treatment, Storage, and Disposal Facilities |
| USQD | Unreviewed Safety Question Determination |
| WMin | Waste Minimization |

# Executive Summary

**Historical Policy**

In the U.S. Department of Energy (DOE), the historical development and implementation of radiological control procedures have generally not incorporated waste minimization considerations. DOE's policy assumed that any waste from a Radiologically Controlled Area (RCA) was contaminated, even though it may not have been.

**Reasons for Change**

However, changing circumstances, such as limited space in disposal facilities, fewer available disposal facilities, and increasing disposal costs, are affecting DOE.

**Industry Success**

Over the past 20 years, the nuclear power industry has achieved major reductions in solid waste. From 1977 to 1991, the reported solid waste from the nuclear power industry shows a downward trend. Because of those results, DOE is interested in learning about and applying those practices to reduce solid waste.

**Project Goals**

The project's focus was to identify and document commercial nuclear power industry best practices for radiological control programs supporting routine operations, outages, and decontamination and decommissioning (D&D) activities. The project goals included

- examining DOE solid low level radioactive waste programs for waste minimization improvements.
- collecting nuclear power industry Best Practices (BPs) and distributing them to appropriate waste generators within DOE.
- making recommendations to minimize low level waste (LLW) at DOE facilities.

**Project Description**

The project team was composed of representatives from DOE facilities, the DOE/Albuquerque Environmental Health Department, and the nuclear power industry. The team

- developed a Work Control Process Model to describe the phases of radioactive waste generation and disposal,
- identified barriers that can prevent change as well as best practices that can improve processes,
- defined metrics and common terminology, and
- identified current best practices.

**Project Description, continued**

Through telephone and written questionnaires, the team gathered data and best practice information from the nuclear power industry and non-utility companies.

**Results**

The main findings from the questionnaire follow:

- Significant progress requires solid management sponsorship.
- The increasing cost of waste disposal was the main driver for waste minimization.
- The simple fix was universal—eliminate waste at the source. Simply unpacking materials outside of RCAs and taking in only what is necessary had the biggest impact.
- Decontamination and free release contributed to waste reduction.
- Launderable items such as Personal Protective Equipment, bags, tarpaulins, and barriers provide significant waste reduction.
- Decontaminable coatings (such as epoxy paints) have reduced the need to cover surfaces with plastic or paper.
- A consulting service performed a site survey and offered an analysis of waste generating processes and costs.

**Recommendations**

The team made the following recommendations to improve low level waste minimization efforts:

1. Provide incentives to encourage waste minimization. Generators should bear the full cost of waste management and disposal and their project budgets need to address waste management. Metrics and goals should be developed in cooperation with waste generators to routinely monitor and communicate performance. Waste management costs should be communicated to all personnel.
2. Waste minimization needs to be actively supported by the highest levels of management. Management needs to provide resources, communicate with personnel, and establish cross-functional teams to address LLW.
3. Sites need to implement technical criteria for proper disposition of waste based on recent DOE guidelines.
4. Include waste minimization practices in all aspects of the work control process. Practices include material substitution, improved volume reduction, minimizing RCAs, improved control of materials entering the RCAs, incorporating waste minimization considerations into procurement practices and facility design and redesign, and using reusable materials inside RCAs.

# 1.0 Introduction

## *1.1 Background*

**Historical Policy**

In the U.S. Department of Energy (DOE), the historical development and implementation of radiological control procedures have generally not incorporated waste minimization considerations. The paramount concern of these procedures was the protection of personnel, the public, and the environment, not waste minimization. The DOE's "zero risk" approach to handling radioactive waste has stressed conservatism by assuming that any material from a radiologically controlled area (RCA) is contaminated, even though it may not be. DOE sites also experienced low waste disposal costs.

**Reasons for Change**

However, changing circumstances are affecting how DOE views waste from RCAs. Some of these circumstances are:

- Disposal facilities for radioactive waste have space limitations.
- The cost of disposal is increasing with higher costs for labor, processing techniques, containers, transportation, and disposal fees and surcharges.
- No new storage facilities are immediately available as radioactive waste disposal facilities become more difficult to license and implement.
- As old disposal facilities close and the opportunities for new disposal facilities become more limited, the need to reduce waste is imperative.
- Executive Orders from the President and commitments from DOE management are mandating increased waste minimization efforts.

**Executive Orders**

Executive Orders signed by President Clinton require federal government agencies to prevent pollution and use recycled products. Specifically, Executive Order 12856 requires federal agencies to develop voluntary goals to reduce generation of hazardous, radioactive, radioactive mixed, and sanitary wastes and pollutants.

**DOE Waste Minimization Mission**

DOE has placed a high priority on waste minimization and pollution prevention, encouraging waste generators to develop programs and request adequate resources to effect long-term savings. DOE Orders 5400.1, 5400.3, and 5820.2A [1,2,3] mandate specific waste minimization requirements for managing radioactive waste. These requirements include process modification, process optimization, and materials substitution.

To provide a strategy for meeting these priorities, the DOE created the Waste Minimization/Pollution Prevention Crosscut Plan [4].

The plan states that DOE's waste minimization (WMin) mission is

> "To reduce generation and release of DOE multi-media wastes and pollutants by implementing cost-effective waste minimization and pollution prevention technologies, practices, and policies, with partners in government and industry while conducting the Department's operations in compliance with applicable environmental requirements."

The Crosscut plan was followed by the Pollution Prevention Program Plan [5] which stressed goals for the reduction of radioactive and low-level mixed waste.

**Industry Success**

Over the past 20 years, the nuclear power industry has achieved major reductions in solid waste. [6] The latter part of the 1980s and the beginning of the 1990s showed a dramatic drop in solid waste, despite increases in the number of operating reactors. For example, in 1977, 42 pressurized water reactors (PWRs) reported 20,900 cubic meters ($m^3$) of solid waste. In 1993, 79 PWRs reported 7,760 $m^3$ of solid waste, a 63% reduction, despite increasing the number of reactors by 90%.

The costs of a better waste minimization program were less than the costs of waste disposal. The nuclear power industry has achieved solid waste reduction without increasing exposure to personnel, the environment, or the public.

Because of these results, DOE is interested in learning about and applying the practices used by industry to effect solid, low level waste (LLW) reduction.

**Sponsor**

The sponsor of this project is the DOE Pollution Prevention Division, EM-77. The division's mission is to plan, coordinate, and develop a DOE-wide Waste Minimization and Pollution Prevention Program to decrease the amount of waste generated by the DOE complex.

### *1.2 Purpose*

**Project Purpose**

The project's focus was to identify and document commercial nuclear industry best practices for radiological control programs supporting routine operations, outages, and decontamination and decommissioning (D&D) activities. The project's goals included the following:

- Examining DOE solid low-level radioactive waste programs for waste minimization improvements
- Collecting nuclear power industry Best Practices (BPs) and distributing them to appropriate waste generators within DOE
- Making recommendations for minimizing LLW at DOE facilities

# 2.0 Project Approach

**Introduction**

The team used the principles of benchmarking to design the project approach. Benchmarking, a quality tool, provided the basis for the methodology used in analyzing DOE internal processes and seeking industry contributors that have successfully implemented waste minimization programs. The benchmarking principles were adapted and modified for this project. This project is not a "formal" benchmarking study.

**Four Major Elements**

The four major elements of the project are listed below:

- **Plan** – Define the project scope, establish management commitment, and establish a team of process experts. Identify the barriers within an organization that prevent change as well as enablers that permit the adoption of Best Practices (BPs). Establish metrics to measure the process being studied. Define the current process to find areas that may be improved and provide a framework for comparison to other organizations' processes.

- **Collect** – Collect data from nuclear industry programs. Using questionnaires, the team collected data that helped identify BPs and how to implement them.

- **Analyze** – Analyze the collected data for

  - qualitative information that provides the BPs and methods for overcoming barriers and
  - quantitative data (metrics) to verify that the organization has been successful. These data provided points of comparison and identified trends.

The analysis tells the team if the information is applicable to the process, and how the information can be used.

- **Adapt** – In typical benchmarking studies, the team implements change based on the analysis. In this project, the team made recommendations because the unique nature of each DOE facility prevents across-the-board implementation. Specific recommendations were made to the CMR facility during the course of the study and are in the process of implementation.

**Project Approach Summary**

The remainder of the report follows the steps of the project structure as follows:

**Section 3.0 Planning**

1. Set Project Scope
2. Assemble Team
3. Develop Team Mission
4. Define Terminology
5. Define and Understand the Work Control Process
6. Identify Critical Barriers and Brainstorm Best Practices
7. Observe Waste Minimization/Health Physics/ES&H Practices
8. Identify Industry Contributors for Best Practice Information

**Section 4.0 Data Collection**

9. Identify Metrics
10. Collect Process Data from Respondents

**Section 5.0 Analysis**

11. Analyze Data
12. Summarize Best Practices

**Section 6.0 Adapt**

13. Make Recommendations

# 3.0 Planning

## *3.1 Set Project Scope*

**Project Scope**

The team narrowed the scope of the project from all radioactive waste to solid LLW resulting from Health Physics (HP) practices. The team reviewed all types of radioactive waste and chose the one in which waste minimization efforts could have the greatest impact.

The project scope was limited to LLW related to nonproduction, contact-handled waste such as plastic floor coverings, repair debris, tools, paper, and protective clothing that is the indirect result of the process. For example, a research item from a glove box is considered a primary source, a direct result of production, and is outside the scope of this project. Hazardous and mixed waste are also outside the scope.

## *3.2 Assemble Team*

**Introduction**

Team members were chosen from DOE sites and the nuclear power industry. Health physicists, waste minimization experts, facility managers, and DOE policy experts participated. The team was composed of representatives from LANL (a DOE site), the DOE/ Albuquerque Environmental Health Department, the nuclear power industry, and Sandia National Laboratories.

**Team Roles and Responsibilities**

The team consisted of a project leader, process experts, management, and support personnel. The team was organized similar to benchmarking teams. The following table identifies the roles and responsibilities of the team members.

| Role | Responsibility |
|---|---|
| Project Leader | Plans, organizes, assigns tasks, and oversees the project |
| Industry and DOE Process Experts | Provide professional expertise on the target process during the workshops, contact industry contributors, and conduct interviews |
| DOE Management | Sets policy and provides support, personnel, time, and funding |

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**Team Roles and Responsibilities, continued:**

| Role | Responsibility |
| --- | --- |
| Support Staff | *Trainer/Facilitator* - Teaches participants benchmarking techniques and leads workshops and work sessions to accomplish goals<br>*Information Specialist* - Aids the search for potential industry contributors through database searches<br>*Writer/Recorder* - Documents the project by recording workshop activities and provides support for project leader, as needed |

**Team Roster** The following roster lists the participating team members.

| Team Member | Title | Location |
| --- | --- | --- |
| Galen Clymer | Senior Quality Auditor | Florida Power Corporation, Crystal River, Florida |
| Theresa Cull | Facility Manager | Chemistry and Metallurgy Research Facility, LANL, Los Alamos, New Mexico |
| Joseph Danek | Manager, Health Physics | Florida Power and Light, Juno Beach, Florida |
| Michael Kennicott | Director, Waste Minimization and Pollution Prevention (PP) Programs | (n,p) Energy, Inc., Albuquerque, New Mexico |
| Diane Leek | Technical Writer | Tech Reps, Inc., Albuquerque, New Mexico |
| Victoria Levin | Project Leader | Environmentally Conscious Life Cycle Systems Department, Sandia National Laboratories, Albuquerque, New Mexico |
| Peter Littlefield | Manager, Radiological Engineering Group | Yankee Atomic Electric Company, Bolton, Massachusetts |

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**Team Roster, continued**

Table, continued:

| Team Member | Title | Location |
|---|---|---|
| Lee McAtee | Deputy Division Director for Environment, Safety and Health | LANL, Los Alamos, New Mexico |
| John Nagle | Professional Engineer | (n,p) Energy, Inc., Albuquerque, New Mexico |
| Patricia Robinson | Chemical Engineer | (n,p) Energy, Inc., Albuquerque, New Mexico |
| Frank Sprague | Environmental Radiation Control Specialist | Department of Energy, Albuquerque, New Mexico |
| Michael Williams | Manager, Nuclear Services | Union Electric, St. Louis, Missouri |

## *3.3 Develop Team Mission*

**Team Mission**

The team's mission was to identify and recommend cost-effective, radioactive solid waste minimization techniques and technologies for application in DOE sites, using benchmarking tools.

## *3.4 Define Terminology*

**Common Definitions**

Industry and DOE process experts often used the same word to define different situations because of their differing professional back-grounds. The group established common definitions to facilitate discussion and analysis that applied to this report only. See definitions below.

**Low Level Waste (LLW)**

Waste that is contaminated or radioactive and is not classified as high-level waste, transuranic waste, or spent nuclear fuel. LLW is routine operational waste that is an indirect result of the process, such as maintenance and decontamination activities. Examples of low level waste include paper, wrapping, work debris, and work by-products such as gloves, tools, personal protective equipment, etc.

**Nonproduction Waste**

Routine operational waste that is an indirect result of the process, such as maintenance, decontamination activities, etc.

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**Production Waste** — Waste that is a direct result of research or production, such as waste generated inside a glove box.

**Radiation Work Permit** — An administrative document used to control work activities, to specify protective measures, and to track radiation exposure (person-rem).

**Radiologically Controlled Area** — An area where radioactive material may be stored or used, such that there is a potential to generate LLW.

**Radworker** — A person who works with or handles radioactive material/waste. Radworkers may generate LLW during normal work activities.

**Waste Disposed** — The volume of waste that has been disposed of, as well as waste that has been prepared for disposal and placed in storage awaiting disposal.

**Waste Generated** — The volume of dry active waste (DAW), filters, sludges, and any activated materials less than Class C[1]. This includes waste which is considered to be "radioactively contaminated" prior to volume reduction processing.

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[1] Class A wastes require minimum precautions for disposal, such as no cardboard boxes. Class B wastes must meet minimum requirements and must have stability. Class B wastes keep their size and shape despite effects on containers from soil weight, moisture, or radiation. Class C wastes must be isolated from a future "inadvertent intruder," a person who accidentally comes upon the waste while digging in the area after the site has been closed. [7]

### 3.5 Define and Understand the Work Control Process

**Work Control Process Model**

As the team examined the LLW-generating processes, the need arose for a common model from which to work. The team defined a Work Control Process Model (Figure 1) to describe the phases of work that affect radioactive waste generation. The model served as a framework for organizing and understanding waste generation and handling processes and it allowed the team to identify opportunities for improved waste minimization. The model represents a combination of input from DOE and nuclear power industry representatives, and therefore does not illustrate one particular process, but rather a generic ideal. The model can be applied to most practices that generate LLW, for example, maintenance work, repairs, and reconfiguring work areas.

**Model Description**

The top of the model shows the **major work groups** that control the process, as follows:

- Health Physics/ES&H Control
- Material/Equipment Control
- Waste Management

Each organization affects how materials and equipment are controlled and how waste management is implemented. Health Physics/ES&H has input at every step. Material and Equipment Control influences the first three steps. Waste Management has input at the third step and controls the last three steps.

The **steps** (center boxes) of the Work Control Process are:

- **Plan (A)** – Involve all affected groups to get input and produce a work package.
- **Job Preparation and Scheduling (B)** – Set up the resources and schedule time for completion of the work.
- **Do the Work (C)** – The work group performs the assigned task.
- **Handle the Waste (D)** – Collect, package, survey, label, and move the LLW.
- **Process the Waste (E)** – Sort and segregate clean waste from contaminated waste, reduce volume, and package waste.
- **Dispose of the Waste (F)** – Ship the waste to the final point and provide for a tracking mechanism.

**Model Description, continued**

Training, the gray bar in the middle of the model**,** provides the underlying knowledge base for all work activity.

**Management** (beneath the steps) oversees the entire process and provides approval for the various steps, including the following:

- Work Plan Approval – Assures the task has been planned properly.
- Job Preparation Checklist – All needed resources have been requisitioned and allocated.
- Work Authorization – Final approval for work.
- Cost-Benefit Analysis – Provides assurance that waste processing and handling is implemented in a cost-effective manner.

**Model Detail**

Each of the steps is discussed in detail in the sections following the model.

### 3.5.1 Planning – Activity A 

**Description**

Every affected department has input during the **Planning** phase (A). Health Physics/ES&H representatives provide input on the radiological hazards and controls for reducing waste. The Planning stage produces a work package that outlines the job materials and scope. Often, one person, the Single Point of Accountability (SPA), is responsible for completion through step D, waste handling.

**Starting and Ending Points**

**Starting Point**
- Work request is initiated

**Ending point**
- Work plan is approved

**Personnel**

The **personnel** involved in Planning are
- Work requester
- Management
- Work group(s)
- Health Physics/ES&H
- Scheduler
- Waste disposal representative
- SPA
- Materials management (including purchasing and procurement) representative

**Inputs**

The **inputs** for Planning are
- Work request
- Definition of the work scope

**Suppliers**

The **supplier** for Planning is
- the work requester

## 3.5.1 Planning – Activity A, continued

**Outputs**

The **outputs** of Planning are

- Approved work plan (package) that contains the following:
  - Task description, including procedures
  - Assessment of hazards associated with the task
  - Plan for waste minimization, including pre-job source reduction, work process considerations, and post-job cleanup

Developing the work plan enables all personnel to contribute to the job definition and consider all job aspects.

**Customers**

The **customers** for Planning are

- Management
- Work group(s)
- Health Physics/ES&H
- Waste disposal representative
- Materials management (including purchasing and procurement) representative

**Subactivities**

The subactivities for Planning are

1. **Develop the Work Plan** - Describe the work scope and discrete work tasks
   - **Assess Hazards** - Identify the nature and type of hazards associated with the work.
   - **Define Waste Considerations** - Define the type, quantity, and character of the waste, and develop a waste minimization action plan.
   - **Define Resource Needs** - Identify the personnel [work group(s)], supplies, equipment, and materials needed for the task.
   - **Write the Work Plan**

2. **Submit the Work Plan and Obtain Approval**

### 3.5.2 Job Preparation and Scheduling – Activity B

**Description**

During **Job Preparation and Scheduling** (B), the work groups, procedures, tools, equipment, and staging are set up. The outcome of this step is the Job Preparation Checklist that assures all aspects were considered in the job planning, including chemicals, materials, procedures, size and composition of the work group, and radiological hazards and controls. The SPA signs off on the checklist and a scheduler assigns a time frame for work completion. The work is authorized, which enables the next stage.

**Starting and Ending Points**

**Starting Point**
- Approved work plan feeds in from the Planning stage

**Ending Point**
- Work is authorized

**Personnel**

The **personnel** needed for Job Preparation and Scheduling are
- Management
- Work group(s)
- Health Physics/ES&H
- Scheduler
- SPA - Work Supervisor
- materials management representative

**Inputs**

The **input** for Job Preparation and Scheduling is an
- Approved work plan

**Suppliers**

The **supplier** for Job Preparation and Scheduling is the
- SPA

**Outputs**

The **outputs** of Job Preparation and Scheduling are
- Work Authorization
- Job Preparation Checklist
- Radiation Work Permit (RWP)

### 3.5.2 Job Preparation and Scheduling – Activity B, continued 

**Customers**

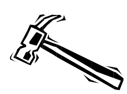
The **customers** for Job Preparation and Scheduling are

- Work group(s)
- Health Physics/ES&H
- Management

**Subactivities**

The **subactivities** (which may advance in parallel) for Job Preparation and Scheduling are

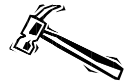
- Scheduling
  - Resource allocation (people)
- Finalizing the RWP
  - Identify radiological hazards and controls, which include protective equipment
- Preparing the workplace
  - Acquire materials
  - Establish radiation and contamination controls
  - Establish waste management controls
  - Establish safety and health controls
- Completing job readiness review and/or pre-job briefing
- Receiving authorization to begin work

### 3.5.3 Do the Work – Activity C 

**Description**

The work group **performs the assigned task** (C). The supervisor is responsible for safety management. At the end of the job, the work crew is responsible for cleanup, removal of tools and equipment, and returning the work area to its original condition.

### 3.5.3 Do the Work – Activity C, continued



**Starting and Ending Points**

**Starting Point**
- Authorization to begin work feeds in from Job Preparation and Scheduling

**Ending Point**
- Work is completed, resulting in a product (completed work) and byproduct (waste)

**Personnel**

The **personnel** needed for the Work activity are
- Work groups
- Health Physics/ES&H
- Waste coordinator
- SPA

**Inputs**

The **inputs** for the Work activity are
- Work tasks
- Job Preparation Checklist
- Work Authorization
- RWP

**Suppliers**

The **suppliers** for the Work activity are
- Work group(s)
- Management
- Health Physics/ES&H

**Outputs**

The **outputs** of the Work activity are
- Product (completed work)
- Byproduct (waste)

**Customers**

The **customers** for the Work activity are
- Work Requester
- Waste Management
- Radworker

### 3.5.3 Do the Work – Activity C, continued

**Subactivities**

The **subactivities** for the Work activity are

- Perform job tasks
- Perform contamination control activities/HP/ES&H control
  - Minimize spread of contamination, including spill control
  - decontamination
  - don and doff protective clothing
  - survey/post
- Manage equipment/materials
  - ID/classify
  - manage movement/coordination
- Sort and segregate materials during work and post-work
- Clean up job area
  - ID and classify
  - perform decontamination
  - survey/monitor
- Review and approve completed job
  - perform post-job review

### 3.5.4 Waste Management – Activities D, E, and F

**Description**

Although some waste management occurs while the job is in progress, the main **Waste Management** activities occur after the work is completed. Personnel must decontaminate the area, move the waste, and survey it. Based on the survey results, the waste may be processed by compaction, incineration, packaging, sorting, segregating, etc. Finally, the waste is disposed of by shipping it to its final destination. Tracking mechanisms for LLW are extensive. This part of the model incorporates the three parts of waste management:

- Waste Handling (D)
- Waste Processing (E)
- Waste Disposal (F)

### 3.5.4 Waste Management – Activities D, E, and F, continued

**Starting and Ending Points**

**Starting Point**
- Solid waste
- Expended materials

**Ending Point**
- Waste ready for final disposition

**Personnel**

The **personnel** needed in Waste Management are

- Health Physics/ES&H
- Analysts
- Movement handlers
- Packaging
- Waste processors
  - on site
  - off site
- Waste management
- SPA (Waste Handling step only)
- Management

**Inputs**

The **inputs** for Waste Management are
- Waste
- Expended materials

**Suppliers**

The **suppliers** for Waste Management are
- Work groups
- Health Physics/ES&H

**Outputs**

The **outputs** of Waste Management are

- Waste ready for final disposition
  - LLW
  - other
- Recyclables
- Reusables

**Customers**

**The customers** of Waste Management are:

- DOE
- Disposal facilities
  - LLW
  - other
- Public
- Recycler

**Subactivities**

The **subactivities** for Waste Management are:

- Treatment
  - sorting and segregating
- Repackaging
- Processing
- Waste handling
  - sorting and segregating
  - moving
- Documentation
- Qualitative characterization
  - Verification/analysis/monitor/sample
  - waste form
  - waste type (LLW or other)
- Quantitative characterization
  - Isotopic identification
- Storage
- Transportation

## *3.6 Identify Barriers and Brainstorm Best Practices*

**Barriers**

In every organization, barriers can impede the ability to change the process. For process improvement to occur, barriers must be identified, and then overcome, worked around, or removed. The team brainstormed barriers to implementing waste minimization best practices in the DOE complex and grouped the barriers into five categories. Next, the team brainstormed possible best practices that could potentially overcome the barriers identified in the DOE complex.

**Main Barriers**

At DOE facilities, the main barriers were identified as the following:

1. **Disincentives vs. Incentives**
2. **Lack of Resources Allocated for Waste Minimization**
3. **Lack of DOE Procedures and Policies**
4. **Lack of Facility Policies and Practices**
5. **Facility Design and Use Limitations**

The barriers are discussed in detail below.

**Disincentives vs. Incentives**

The incentives to adopt new Best Practices are not strong enough to outweigh the disincentives present in DOE facilities.

The major **disincentives** are

- no or little direct cost to generator for disposal,
- added labor for waste minimization, and
- consequences of making a mistake.

In many cases, Defense Programs (DP) generate the waste, but an entirely different organization (Environmental Management (EM)) pays for waste disposal. The generators have no knowledge of the **cost** of radioactive waste disposal and experience little cost impact on their budgets. (Generators may be charged a small fee. See Incentives portion.)

Reducing waste requires more **labor** to sort and segregate, characterize, assay, and package the waste as it is generated. It requires little effort for generators to simply label all waste from the RCA as radioactive waste and send it to a receiving area.

Segregating waste into “clean” and radioactive waste involves the risk of human error. If a mistake is made, the **consequences** could be severe, as follows:

- DOE could place a moratorium on radioactive-waste-generating activities.
- Fines could be imposed on the facility.
- Negative public relations.
- DOE could close the facility, resulting in the loss of jobs and research efforts.

**Incentives vs. Disincentives, continued**

The **incentives** are:

- Avoiding the charge-back fee on the radioactive waste. This fee is a fraction of the true cost of waste management and disposal. Waste generators may be charged less than 1% of waste management costs.
- Reducing LLW lengthens the life of the low-level waste disposal facility, which supports program continuation.

The question associated with this barrier is, “No matter how good the best practices are, why adopt them when the risks are so great, the potential negative outcomes are significant, and the rewards are negligible?”

**Lack of Resources**

Organizations have few personnel, if any, assigned to waste minimization. The Cross-Cut Plan recognizes that “lack of sufficient staff and resources has limited the effectiveness of WMin/Pollution Prevention on Departmental operations.”

**Lack of DOE Procedures and Policies**

There are no technical criteria for differentiation between radioactive and nonradioactive waste for DOE sites. In contrast, the nuclear power industry uses technical criteria to differentiate waste. The barriers created by the lack of DOE procedures and policies are the following:

- DOE has not defined an acceptable lower limit of detection (LLD) that could provide a basis for waste definition.
- DOE has not defined a risk-based approach for release.

  ***NOTE:*** *Since this workshop was held, DOE has issued technical guidance that provides for disposal of materials and property containing residual radioactive material. A table of values has been established that provides surface activity guidelines that define limits for disposal of radioactive materials in:*
  - ΔΟΕ ορ νον–ΔΟΕ λανδφιλλσ,
  - Ρεσουρχε Χονσερϖατιον ανδ Ρεχοϖερψ Αχτ (ΡΧΡΑ) Τρεατμεντ, Στοραγε, ανδ Δισποσαλ Φαχιλιτιεσ (ΤΣΔΦ), ανδ
  - τρανσφερ οφ οωνερσηιπ το μεμβερσ οφ τηε πυβλιχ.

- ΔΟΕ ηασ νοτ εσταβλισηεδ γυιδανχε φορ μετριχσ.
- Λιφε χψχλε χοστσ αρε νοτ χονσιδερεδ βψ ΔΟΕ.
- Ωαστε μινιμιζατιον χονσιδερατιονσ αρε νοτ υσεδ φορ πυρχηασε σπεχιφιχατιονσ.

**Lack of DOE Procedures and Policies, continued**

- Military specifications (milspecs) that control the acquisition of certain materials are outdated, do not incorporate waste minimization considerations and are difficult to change.
- Stringent reporting requirements result in increased use of protective clothing.

**Facility Policies and Practices**

Some facility policies affect the efficiency of waste management, as follows:

- It is estimated that 60–80% of the waste disposed of as radioactive at LANL is not radioactive. The general philosophy has been to treat all waste from the RCAs as radioactive.
- Job preparation focuses on worker health and safety and does not include waste minimization considerations.
- The research and development environment makes standardization of waste minimization practices difficult to achieve. There is a cultural resistance to the concept that work control processes can be similar among unique projects.
- Waste reduction goals are developed without input from the people who perform the work.
- Waste minimization is not a high priority.
- Waste minimization is not considered in purchasing practices, especially with regard to materials packaging.
- No formal program is in place for material and equipment (M&E) flow and control in RCAs.

**Facility Design and Use Limitations**

The following were identified as facility design and use limitations:

- Some facilities were built 30 or 40 years ago when waste minimization considerations were not incorporated in the building design. Physical plant limitations can make waste minimization difficult.
- There is a lack of process knowledge from past usage that can be applied to waste characterization. Documentation may not be available for specific room usage of 30 years ago.
- Many DOE facilities use alpha-emitting isotopes, which are much more difficult to detect than the beta-gamma emitters used in the nuclear power industry.

**Best Practices**

After examining the barriers that hinder adoption of better waste minimization processes, the team brainstormed Best Practices that could be pursued to counteract the barriers:

1. Use risk-based decision making.
   - Use decontamination and survey techniques to reduce RCAs.
   - Develop procedures for sorting, segregating, and verifying clean waste.

2. Integrate waste minimization concepts into work control/planning systems.

3. Inform and incentivize waste generators.
   - Develop metrics related to waste minimization goals.
   - Develop a system that places the responsibility and accountability for waste disposal costs and volumes on the generator.
   - Increase WMin training efforts, including management.

### 3.7 Review Waste Minimization/Health Physics Practices

**Develop Understanding**

The team visited the Chemistry and Metallurgy Research (CMR) facility at LANL to develop an understanding of waste minimization/health physics practices at DOE facilities. Waste minimization practices at the CMR facility were reviewed by the team. Some of the best practices identified in section 3.6 were linked to practices at the CMR facility for potential implementation.

**Overview**

The CMR facility is a nonreactor nuclear facility occupying more than 500,000 sq. ft. RCAs comprise about one-third of the total. The facility has six operational wings. Approximately 400 individuals work in the building. The facility has been operating since 1952.

The team visited two representative areas:

- A typical research and development area where analytical chemistry is performed. The radiation concerns are primarily alpha emitters. (americium and plutonium)
- The hot cell facility. The primary radiological concerns are beta and gamma radiation and radioactive particles. The area is also used for spent fuel rod storage. Plutonium contamination is possible from past operations.

Some of the contamination present is a result of previous work at the facility. When contamination is noted, it is not always known whether it resulted from past or present operations.

The group toured a representative portion of the facility and discussed

- the use and control of radioactive materials,
- the major radioactive waste streams, and
- waste handling.

**CMR Processes**

The team mapped the Work Planning and Solid Radwaste Management processes at the CMR facility. Refer to Appendix A for details.

## 3.8 Identify Industry Contributors for Best Practice Information

**Potential Contributors**

Potential industry contributors were identified by brainstorming. Team members used personal knowledge of the company's or facility's reputation in the industry to identify possible contributors. Next, the team developed criteria to help identify contributors with good Health Physics/Waste Minimization practices that could be applied to DOE facilities.

**Criteria**

The team defined criteria for potential industry contributors. A good potential source must have or show:

- Low waste generation per megawatts electric MWe (normalized factors)
  - PWR
  - BWR
- Low waste generation per RCA entry or RWP work hours
- A decreasing trend in waste generation volume and costs
- Similar processes or activities to DOE facilities
- Decreasing numbers and sizes of contaminated areas
- Posted areas similar to DOE
- Low dose exposure relative to waste generation
- A willingness to share information
- Records or data of waste generation
- No serious violations identified through Environmental Protection Agency, Nuclear Regulatory Commission, Department of Transportation, etc.

**Information Sources for Identifying Potential Contributors**

A variety of methods and sources for identifying potential contributors, including the following, were used:

- Literature search by an information specialist
- Process experts' suggestions
- Trade associations or publications

# 4.0 Data Collection

## *4.1 Identify Metrics*

**Background**

Metrics provide measures of a process against a standard. Metrics allow evaluation and assessment of existing performance and provide points of contrast after implementing changes.

Using process knowledge, the team brainstormed metrics that would be useful in tracking waste minimization progress and could be used to develop questions for selecting appropriate partners.

**Selected Metrics**

The team defined metrics and ranked them in importance relative to reductions in LLW. To reveal trends, the team decided to collect three years of data. The final metrics used for collecting data from industry contributors were:

- Volume of waste **generated** in $m^3$ of
  - filters
  - Dry Active Waste
  - Activated metal < Class C (see Section 3.4)
  - Sludges and evaporator bottoms
  - Resin resulting from coolant cleanup and liquid radioactive waste treatment
- Volume of waste **disposed** in $m^3$ for same items as above
- Number of reactor units/types/size
  - Units = # of operating reactors per site
  - Type = Pressurized Water Reactor (PWR) or Boiling Water Reactor (BWR)
  - Size = Rating in gross MWe
- Power output per operating cycle in MWe
- Number of outage days
- Collective dose per cycle (person-rem/cycle length)
- Total RCA, expressed in square feet, excluding containment
- Total contaminated area (in $ft^2$)
- Cost of waste management program
- Number of RCA entries
- Number of work packages in the RCA (A work package could be for technical specification surveillance, repairs, preventive maintenance, or similar activities.)
- Number of PCs (protective clothing) used

## 4.2 Collect Process Data from Respondents

**Data Collection Methods**

Once the list of potential industry contributors was developed, data were gathered through telephone and written questionnaires that sought data from nuclear power plants and non-utility companies. Refer to Appendix B for the questionnaires used in this project.

**Questionnaire Development Process**

The team developed two questionnaires:

- a telephone questionnaire to provide a filter to determine industry interest and broad suitability, and
- a written questionnaire to elicit detailed information about Best Practices.

**Questionnaire Structure**

The team discussed what information would help them find contributors. The questionnaire asked for information about

- Best Practices
- Barriers to implementation
- Success factors that enabled overcoming the barriers
- Policy and management issues, including training
- Site-specific metrics to show overall trends in waste

**Results**

Of the 40 initial contacts made by telephone, 25 of the companies

- had processes appropriate for comparison to DOE's process, and
- were willing to participate.

Written questionnaires were sent to these companies. Of the 25 written questionnaires sent, twelve were returned. (This return rate of 48% is average compared to the average return rate of 30–60% for pre-screened written questionnaires.)

# 5.0 Analysis

## *5.1 Analyze Data*

**Findings**

The main findings from the questionnaire follow:

1. Significant progress requires solid management sponsorship. In several cases, upper management required special reporting which highlighted waste minimization efforts and held individuals accountable.
2. The increasing cost of waste disposal was the main driver for waste minimization.
3. The simple fix was universal—eliminate waste at the source. Simply unpacking materials outside of RCAs and taking in only what is necessary had the biggest impact.
4. Decontamination and free release were significant waste reduction factors.
5. Launderable items such as Personal Protective Equipment, bags, tarpaulins, and barriers provide significant waste reduction.
6. Industry has made an increased effort to minimize RCAs and reduce protective clothing requirements.
7. Decontaminable coatings (such as epoxy paints) have reduced the need to cover surfaces with plastic or paper. Now, decontamination teams can mop floors or wash walls and process liquid waste from buckets rather than using bulky plastic and paper lay-downs.
8. Some respondents use incinerable materials to maximize volume reduction. Some have incinerators on site.
9. Electric Power Research Institute (EPRI) surveys have helped convince upper management of the feasibility of better waste management processes. EPRI provides a consulting service that performs a site survey and offers an analysis of waste generating processes and costs.
10. Several respondents credited the efficiency of their program to giving one department total responsibility for managing radioactive waste from cradle to grave.

## 5.2 Summarize Best Practices

**Team Work Best Practices**

The questionnaire respondents reported the use of teams to implement waste minimization in the following BPs:

- Cross-functional teams assess waste generation and recommend changes. By including personnel from all departments, communication among work groups improves. The teams are given a specific problem to solve. Each member brings a different perspective and expertise. When the work groups have a voice in the solution, implementation is smoother.
- Establishment of a formal program, including a waste minimization council that meets regularly, focuses on and tracks activities, identifies waste-related costs, and issues formal reports.
- Benchmark performance against others. With thorough preparation and background research, visits to other companies can be beneficial.
- Frequent communication is maintained with all station personnel regarding performance indicators.
- Work groups concentrate on specific problems, such as chemical control, resin use, waste generation, reuse of tools, etc. Information from reports was used to establish a task force on water management and its effect on resin generation.
- Work-group meetings/discussions are held on radioactive waste initiatives.
- Knowledge of costs is given to work groups. When workers are aware of the costs of waste management, they become more involved in the process.
- Employee awareness and teamwork is encouraged. Feedback and suggestions from all employees regarding waste minimization improvements are sought.

**Management BPs**

The questionnaire respondents reported management support as a key to implementing better waste minimization practices. The examples below demonstrate the impact of management in this area.

- "Management has taken an active role in communicating radioactive waste issues, expectations, and responsibilities to the plant staff and contractors. This strategy has caused everyone to feel part of a team, working for a common goal."
- "Measure and track low-level radioactive waste generation, disposal volumes and program costs. You must know exactly what constitutes the waste before you can find ways to reduce it. Hard data helps convince others to support change."
- "Visible senior management support. The vice president speaks about waste minimization at regular 'all-hands' meetings. A new waste minimization training video was introduced by the vice president. Quotes from upper management appear in the plant waste minimization newsletter."
- "One management individual is dedicated specifically to waste minimization. This individual tracks generation of radioactive waste and reports to management."
- "A cost-benefit analysis of operations is used to determine the best methods to achieve cost effectiveness."
- "Talk to people in the parking lot to ask opinions and foster an atmosphere of information exchange."
- "We switched radioactive waste disposal contractors to improve efficiency and service."
- A Radwaste Elimination and Management Team recommends and implements hands-on, day-to-day practices that affect treatment of LLW generated.

**Program BPs**

The following BPs were listed as key program changes that encouraged waste minimization:

- Minimize materials brought into RCAs; increase emphasis on survey, decontamination and release of materials from RCAs.
- Review operations regularly to identify methods to reduce waste volume. Avoid complacency.
- Some waste generators use an outside vendor to provide waste minimization services such as free release, incineration, compaction, disposal, etc. (However, caution must used. One participant recommended writing a performance-based contract and visiting the contractor facilities to verify that the promised techniques and procedures are in place.)

**Training BPs**

Training was a universal BP for all respondents. Specialized training ideas include:

- Emphasizing the importance of waste minimization to control costs and ensure that the plant is competitive.
- Training management/supervisors in mixed waste minimization. (Finding suitable substitutes.)

**Volume Reduction BPs**

Volume reduction methods improved efficiency of waste minimization operations with the following BPs:

- Segregate clean items from contaminated items and perform free release surveys of clean items
- Decontamination and free release
- Decontaminate materials and release for reuse
- Sort radioactive trash to maximize volume reduction efficiency (incineration, compaction, decontamination, and recovery of metals and tools)
- Package waste efficiently - minimize void space.
- Use compaction and supercompaction
- Off-site vendor provides incineration
- Use metal melt
- Shred cotton or paper filters so they can be compacted
- Careful use of incinerable items
- Implement measures to reduce filter usage (scrubbers, cleanable prefilters)

***ABANDONED*** **Volume Reduction Methods**

The team was also interested in identifying volume reduction methods that are no longer used, including:

- On-site drum and box compaction of DAW was discontinued by some because it was inefficient and less cost-effective than vendor processing.
- Drum compactors were inefficient, resulting in poor volume reduction and handling problems.
- One respondent reported that supercompaction is used less frequently because other strategies, such as using launderable items, have lessened the need for volume reduction.

**Source Reduction BPs**

Source reduction was the most popular way to reduce waste, especially careful monitoring of items going into the RCA. Source reduction methods included:

- The "Green Is Clean" program. Sort and segregate material based on the potential for contamination. (One participant reduced the percentage of clean material in radioactive trash from 44% to 3%.)
- Aggressive sorting and segregating prior to shipping waste to a vendor for processing.
- Radiation protection staff oversees everything that is taken into the RCA. By questioning workers about equipment and supplies, large quantities of unneeded equipment and supplies never enter the RCA.
- Expanding in-house decontamination, $CO_2$ blaster, grinder, etc.
- Drying (air-dry or forced-air-dry) wet items such as filters, mopheads, or soil instead of adding absorbent. Using a ventilated, monitored area for drying.
- Using launderable substitutes for consumable items – concentrating on eliminating plastics. For example, using cloth tarpaulins instead of plastic sheets. One company is experimenting with sheets of metal that can be decontaminated and reused.
- Adopting an aggressive program of repairing leaks in the plant to minimize contaminated areas. Operations, Maintenance, and Radiation Protection work together to identify and correct any leaking systems within the RCA. Fewer contaminated areas generate smaller volumes of radioactive waste.
- Maintaining the plant scrupulously and performing decontamination prior to doing the work. The plant decontamination crew also processes radioactive waste and reports to Health Physics/ES&H.
- Eliminating tape, surgical gloves, cotton liners, and disposable booties from anticontamination (anti-C) dressout requirements.
- Controlling issuance of cover materials such as herculite.
- Eliminating herculite, if possible. If not, mopping herculite rather than using multiple layers.
- Using rags that dissolve at higher temperatures.
- Identifying the specific rooms/areas that generate the most protective clothing and LLW and reviewing operations within those rooms to identify the reasons for high rates, then changing operations as needed.
- Installing/improving scrubbers and pre-filters upstream of High Efficiency Particulate Air filters (HEPAs) to reduce LLW and mixed waste HEPAs.

**Reuse/Recycle BPs**

Reusing durable items, such as tools, and substituting launderable items for disposable items were the most beneficial items in this category. Additional insights were as follows:

Tools
- Adopt a contaminated tool reuse program. Each RCA has its own tool supply, with a central tool issue point.
- Decontaminate tools for free release to prevent building an excessive inventory.
- Create an on-site tool decontamination shop.
- Use high pressure water spray or $CO_2$ to clean equipment and metals.

Scaffolding and Pallets
- Store contaminated scaffolding on site and reuse. Use aluminum, reusable scaffolding rather than wood scaffold planks.
- Use plastic pallets instead of wood.

Launderable Items
- Use launderable bags and tarpaulins in the RCA.
- Wash protective clothing on site for reuse.
- Use washable mop heads, clothes, bags, and barriers.

Other
- Decontaminate filter elements (when practicable) and return them to service.
- Identify contamination levels on reusable items with three levels of color coding.

**Metrics**

Metrics used by respondents included:

- Volume and weight of waste generated.
- Volume and weight of waste disposed.
- Program costs.
- Monthly measurement of radioactive waste generated for four waste streams: DAW, filter media, resins, and used oil.
- Volume reductions for incineration and supercompaction reported on monthly reports supplied by a commercial DAW processing service.
- Bags of radioactive waste generated, including the contents and origins, are tracked. If overwrapping or other items are found that should be banned from the RCA, investigate the cause.
- Track “Green is Clean” data.

**Source of Ideas**

The questionnaire respondents listed a variety of ways for learning new ideas for improving radioactive waste operations:

Employees

- Employees may leave voice mail on a radioactive waste minimization phone line. The manager of the department responds within a day.
- Feedback from group meetings.
- One-on-one discussions with workers and radioactive waste team staff.
- Employees can send ideas (signed or anonymously) to the radioactive waste group. Management expects these suggestions to be reviewed, addressed in a timely manner, and answered. Interdepartmental teams address issues that have an impact on the organization as a whole.

Teams and Outside Sources

- EPRI survey and suggestions.
- Interdepartmental Waste Reduction Team brainstorms ideas.
- Research from other companies.
- Radwaste Reduction Task Force generates ideas (management is highly involved in Task Force).
- Internal Health Physics/ES&H Division brainstorming sessions, particularly within the Waste Minimization Team.
- Industry meetings where other power plants share ideas.

**Employee Education and Awareness**

The questionnaire respondents addressed employee education and awareness in a variety of ways, as follows:

- Show workers the true cost of waste generation by giving them data on cost, volumes, and impact on budgets.
- Daily newsletter for reading during lunch and breaks.
- Site-wide voice mail - A standard message sent to everyone in the plant.
- Pre-outage briefings with each work group.
- Short presentation during in-processing training for outage personnel.
- Meeting with each work group to explain radioactive waste goals and how the group can do their part.
- General employee training.
- Communicating frequently with employees and responding to their concerns.

**Employee Education and Awareness, continued**

Questionnaire responses, continued:

- Work group meetings discuss radioactive waste minimization initiatives.
- Remote TVs at designated locations highlight solutions to problems.
- Pre-job meetings.
- Bulletin boards.

**Employee Incentives and Awards**

Employee incentives and awards used by the respondents ranged from none to small-item give-aways, as follows:

- "None. Waste minimization is part of the job, not an add-on."
- "The major incentive, understood from the VP on down, is to reduce costs to keep the utility a competitive operating nuclear power plant."
- "Incentives are part of the productivity improvement program, but not specific to radioactive waste."
- "Trinket give-aways for demonstrated knowledge of waste costs and minimization methods."

**Financial Responsibility**

The respondents reported a variety of methods for financial responsibility, including:

- One department responsible for radioactive waste collection, shipping, processing, and burial.
- Radiological Services department oversees the effort. Collection is performed by plant helpers (also in Radiological Services). Maintenance assists with shipping, but costs are strictly overhead and maintenance. All invoiced costs from vendors are covered by the Radiological Services budget.
- Health Physics/ES&H Department bears the cost and is budgeted for collection, shipping, processing, and burial.
- Specific charge numbers are assigned for waste management activities for capital projects, large operations and maintenance projects, and mobile maintenance items during refueling outages.

**Work Performance**

One of the questions asked which departments or groups collected, packaged, and shipped the radioactive waste. Some respondents said one organization was responsible, others said a variety of groups shared the responsibility. Regardless of the structure, the respondents cited teamwork and close working relationships as the major ingredients for efficient procedures. Overall, the concept of Health Physics/ES&H and radioactive material control being service organizations helped sell the benefits of close working relationships to other groups.

**Barriers**

The main barriers reported by the respondents were as follows:

***Employee Resistance***

Employee resistance is an ongoing problem at many plants. Improving education and communication programs and addressing employee concerns quickly with hard data were successful strategies for overcoming employee resistance.

“Old habits die hard,” said one respondent. “Education and increased awareness, supported by management, were necessary to get buy-in from employees to go the extra mile to reduce waste.”

At one plant, hose control was a problem. “By focusing on this problem and talking to work groups, employees made a better attempt to reuse stock and prevent excessive waste generation.”

***Management***

Prior to a reorganization at another plant, waste production, processing, packaging, and disposal responsibilities were maintained in four different departments with little coordination or oversight. A department reorganization created one group to consolidate waste processing and disposal responsibilities and manage the budget.

“Management needs to acknowledge the actual cost of waste management,” said another respondent.

**Barriers, continued**

*Company Culture*

"Waste management and disposal were not high priorities until increases in disposal costs drew senior management's attention. To overcome this barrier, disposal cost information has been put into training materials to increase general awareness. New educational efforts will be implemented in 1996."

"Work practices were performed without regard for waste minimization. Common practice and habit are hard to change. Significant education and procedure revision effort, along with good management support, was necessary to break this barrier."

"Company culture allowed tools and protective clothing in the trash. We had to work with employees to change this."

"Company culture barrier was overcome by going directly to work-groups, talking about the cost and impact and how to fix the problem."

***Barriers From Outside of the Plant***

Management focused on Institute of Nuclear Power Operations (INPO) indicators that stressed volume, not cost, which can result in excessive cost to reduce an insignificant volume of waste.

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**Enablers - Success Factors**

Enablers are the success factors that allow organizations to put best practices into place.

***Company Culture***

"The site has excellent communication and teamwork between groups. The teamwork fosters an excellent attitude in all areas to improve and attain excellent performance. Employee awareness efforts and education are critical to ensure the team knows how to perform well."

***Management Structure***

"Management has been supportive by supplying the resources needed to determine and establish good practices and implement employee suggestions."

"Management involvement and support are critical."

**Enablers - Success Factors, continued**

*Management Structure, continued*

"The company does not have a radioactive waste department, but instead has a radiation protection department that handles all waste management aspects."

***People***

"The staff is an extremely stable, dedicated team with a clear common goal. The changes came primarily from workers' ideas, not management. Employees are aware of the cost, storage, regulatory, and burial problems associated with radioactive waste generation."

"Our people are the best factors. Once convinced of the need and importance of a new way of working, they will work hard on implementation."

"If people find a cost-effective way to reduce radioactive waste, they are empowered to just do it."

"The biggest impact was the determination and persistence of the staff and supervision to turn around the trend of our falling status compared to rest of the industry."

# 6.0 Recommendations

**Team Recommendations**

The team reviewed all best practices, both those collected from industry contributors and those generated within the team, and selected those that would have the most impact on waste minimization efforts in the DOE complex. Based on the information gathered by the questionnaire and the circumstances present at DOE sites, the team made the following recommendations to improve low-level waste minimization efforts:

**Provide Incentives**

1. Provide incentives to encourage waste minimization.
   a. Generators should bear the full cost of waste management and disposal and their project budgets need to address waste management.
   b. Develop metrics and goals in cooperation with waste generators to routinely monitor and communicate performance. The metrics should be
      - measurable,
      - controllable,
      - understandable, and
      - standardized, as appropriate, by site.
   c. Convey actual waste management costs to management and workers.
   d. Define and convey to managers and employees the positive and negative consequences of meeting or not meeting waste minimization goals.

**Gain High-Level Management Support**

2. Waste minimization needs to be actively supported by the highest levels of management. Management needs to

   a. Provide adequate resources for awareness, training, incentives, equipment, personnel, etc.
   b. Have frequent communication regarding waste minimization with all site/facility personnel.
   c. Solicit waste minimization ideas and strategies from both inside and outside the site, for example, workers, industry meetings, publications, benchmark surveys, and other sites.
   d. Establish cross-functional waste minimization teams to assess waste practices and recommend improvements.

**Implement Technical Criteria**

3. Sites need to implement technical criteria for proper disposition of waste based on recent DOE guidelines.
   a. Each site should develop procedures to implement technical criteria for sorting, decontamination, segregation, clean waste, and verification measurement/survey techniques.

DOE sites can now take advantage of technical guidance issued in November 1995. This guidance provides for disposal of materials and property containing residual radioactive material. A table of values has been established that provides surface activity guidelines that define limits for disposal of radioactive materials in:

- DOE or non-DOE landfills,
- Resource Conservation and Recovery Act (RCRA) Treatment, Storage, and Disposal Facilities (TSDF), and
- transfer of ownership to members of the public.

**Integrate WMin Throughout Work Control Process**

4. Include waste minimization practices in all aspects of the work control process. Waste minimization practices include:
   a. Source reduction through
      - Material substitution such as launderable PCs rather than disposable.
      - Incinerable materials vs. non-incinerable
   b. Minimize RCAs
   c. Include waste minimization considerations in procurement
   d. Improve controls on materials entering the RCA
   e. Include waste minimization considerations in facility design/ redesign.
   f. To the maximum extent possible, use reusable materials such as metal scaffolding, dedicated tools, plastic pallets, and contaminated barriers.
   g. Use volume reduction to further minimize LLW. Examples include compaction, incineration, sorting, segregating, efficient packaging, etc.

**Implementation**

To implement best practices, the team recommends the following approach:

1. Identify metrics and collect data for metrics that are meaningful for your facility.
2. Prioritize the best practices that you want to implement, based on the metrics data and the potential cost/benefit return.
3. Select three to five best practices for implementation.
4. Get senior management buy-in by presenting the metric and cost-benefit data.
5. Establish an action plan for implementation.
6. Publicize and communicate goals throughout the organization.
7. Track progress by reporting on the metrics periodically.
8. After successful implementation, select 3-5 more best practices and revisit the process.

# REFERENCES


1. Department of Energy, DOE Order 5400.1, General Environmental Protection Program, November 9, 1988.

2. Department of Energy, DOE Order 5400.3, Hazardous and Radioactive Mixed Waste Program, February 22, 1989.

3. Department of Energy, DOE Order 5820.2A, Radioactive Waste Management, September 26, 1988.

4. U.S. Department of Energy, Office of the Secretary, Waste Minimization Pollution Prevention Crosscut Plan (WM/DDCP), February, 1994, Washington, D.C.

5. U.S. Department of Energy, *Pollution Prevention Program Plan*, March, 1996, Washington, D.C.

6. Tichler, J.; Doty, K.; Lucadamo, K.; “Radioactive Material Released from Nuclear Power Plants, Annual Report 1993”, NUREG/CR-2907, BNL/NUREG-51581, vol. 14, May 1995, Upton, NY.  URL:  http://arm3.das.bnl.gov/sisg/nrc.html

7. Murray, Raymond L., *Understanding Radioactive Waste*, Fourth Edition, 1994, Batelle Press, Columbus, Ohio

# APPENDIX A

## Waste Minimization/Health Physics Practices at the Chemistry and Metallurgy Research (CMR) Facility February 1995

## *A1. Waste Min/Health Physics Practices at CMR*

**Flow Chart - Work Planning Process**

The Work Planning Process (Figure A-1) begins with a work request from a customer. For minor activities, (job cost estimated to be less than $2,000) the area coordinator writes a small job ticket and submits it to the Environment, Safety and Health (ES&H) department for review. ES&H completes the Special Work Permit (SWP) if there are any industrial hazards (such as confined spaces, drilling, or spark- or flame-producing activity). Health Physics completes the RWP if radiological hazards are present. The ES&H questionnaire identifies all hazards associated with an activity and which permits are required. Facility management reviews and approves the forms and authorizes the work.

For large jobs, (greater than $2,000) the customer completes a change control form. The area coordinator determines whether a Change Control Board (CCB) Review is required. The board is convened when there is a physical change to the facility that needs to be documented (such as facility drawings). If not, the job can be completed through the same pathway as a small job. Part of the CCB review asks whether an Unreviewed Safety Question Determination (USQD) is required. The CCB may be able to do an initial screen on the USQD. The CCB also determines whether a formal design is required (mainly for quality assurance issues.)

If a formal design is required, Facility Safeguards and Security creates the project design, which must be reviewed and approved by the customer. When the design is finalized, the CCB determines whether an ES&H Review is required. If so, the same path is taken for ES&H questionnaires, RWPs, and SWPs as for small jobs. Finally, an Operational Readiness Review (ORR) may be required. This independent review ensures all safety controls are in place before the crews start work. The ORR may take several months to complete.

After completion of all requirements, the work is authorized.

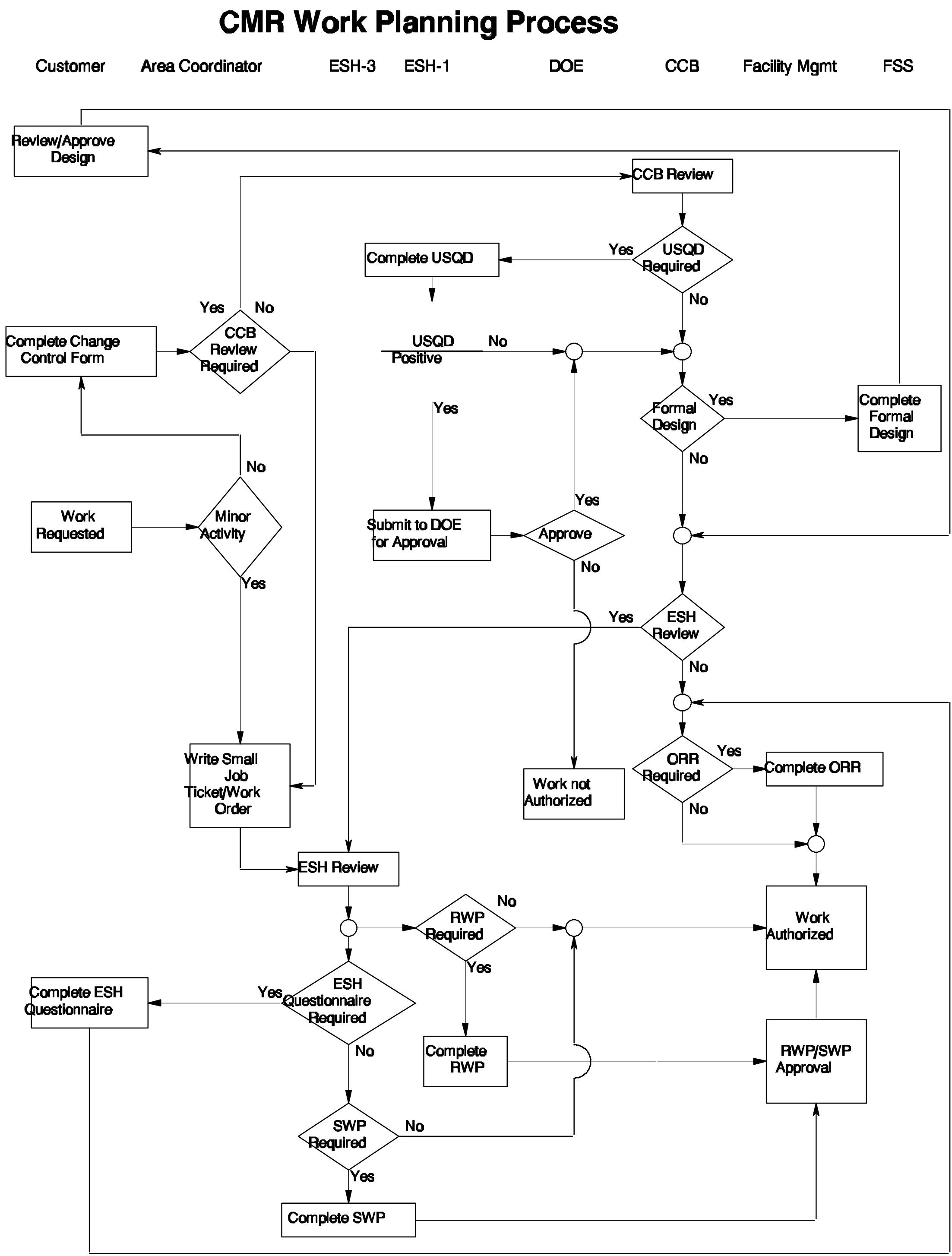


*Figure A-1. CMR Work Planning Process*

**Key**

The acronyms for these flow charts follow:

CCB - Change Control Board
DOE - Department of Energy
ESH - Environment, Safety, and Health Department
FSS - Facility Safeguards and Security
HPGe - High Purity Germanium Detector
ORR - Operational Readiness Review
RWP - Radiation Work Permit
SWP - Special Work Permit

**Flow Chart - CMR Solid Radwaste Management Process**

The generator determines whether or not the waste is transuranic (TRU). If it is, the waste goes into a 55-gallon drum and follows a different path for disposal.

For low-level radioactive waste, the size and type of the object determines whether it is treated as routine or nonroutine waste from a Radiologically Controlled Area (RCA).

Large items and unusual objects such as wall panels or heavy debris will be placed in a designated area by the generator. Health Physics will monitor the items by hand. If the item is not above background, it is placed in the “suspect” box for disposal. If the item is above background, it must be monitored with a High Purity Germanium (HPGe) detector. The generator must document the type of materials and contamination. After receiving approval for disposal from the waste services department, the generator must initiate a waste disposal request that describes the volume of the material. Waste Services reviews and approves or disapproves the request.

For routine RCA waste, items are placed in a cardboard box and monitored by hand. If the reading is less than .5mR/hr, and less than the contamination limits, the box is transported for security monitoring. If the readings are acceptable, the box goes through the same documentation and approval process as nonroutine RCA waste.

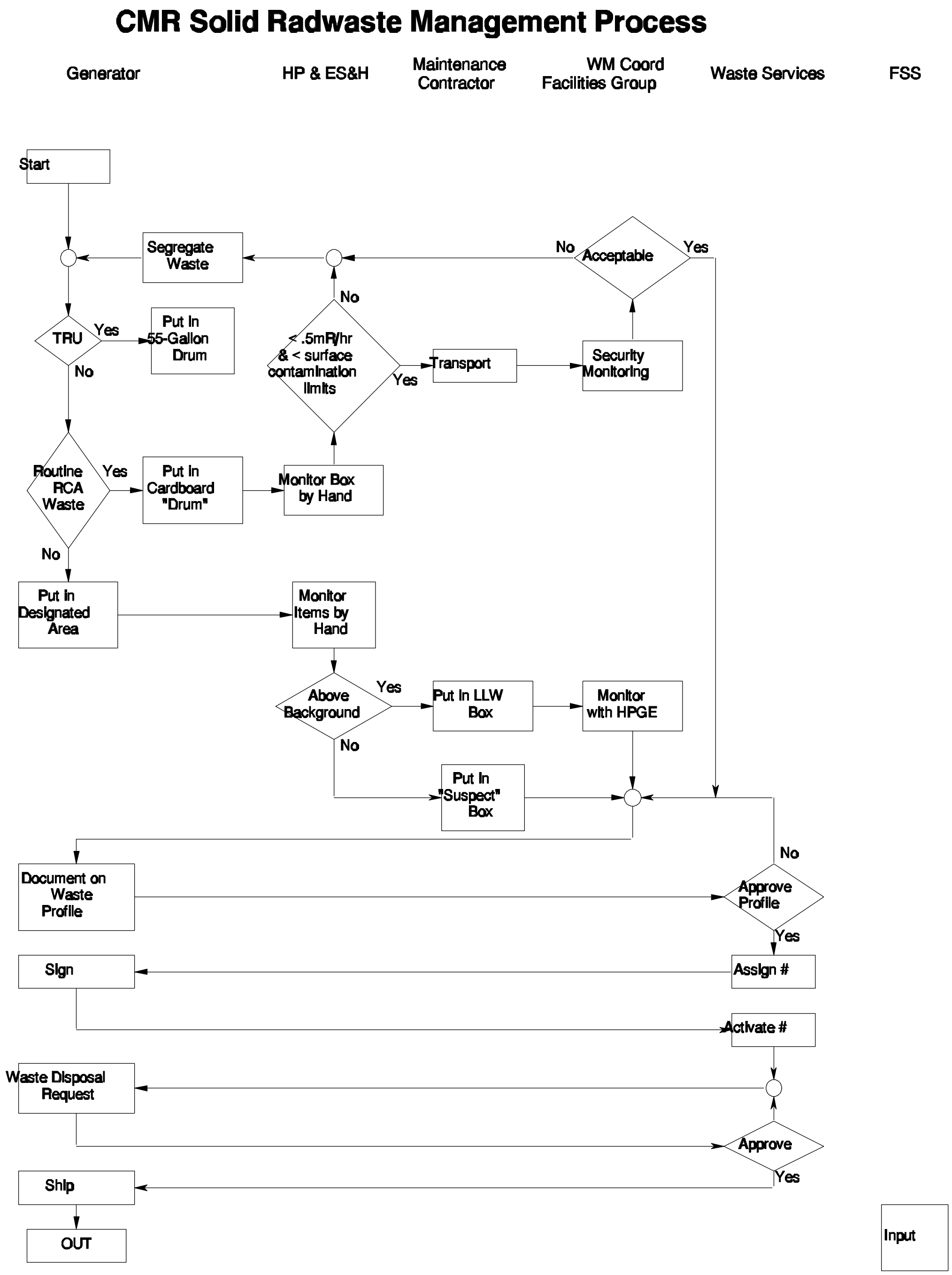


*Figure A-2. CMR Solid Radwaste Management Process*

## A1.1 Team Observations of CMR Facility

**Health Physics/ES&H Aspects**

The team discussed the Health Physics/waste minimization practices at the CMR facility and grouped them by broad category.

### 1 Waste Classification

- Waste disposal is a process-based, not measurement-based decision. CMR does not have release criteria.
  - A lot of waste was assumed to be radioactive that may not be.
  - At CMR, monitoring is for Health Physics purposes and is not used to segregate waste.
- All waste that originates from an RCA goes to an on-site disposal area for LLW.

### 2 Management Issues

- Work planning does not focus on waste minimization. For example, some new equipment in an RCA had shrink wrap and intact cardboard boxes on a wooden pallet. When the desired items were unpacked inside an RCA, the outside wrapping and pallet became solid low-level waste. By removing all excess packaging before hand-carrying the items into the RCA, some waste could be eliminated.
- Waste minimization efforts are limited by lack of resources and prioritization.
- A complex management structure makes buy-in difficult.
- Segregation of responsibilities between Health Physics/ES&H, Waste Services, operations, and other work groups does not encourage waste minimization. The goal of each group is different and sometimes contradictory.

### 3 Facility Information

- The physical plant is old and there is incomplete knowledge of previous usage because of the diversity of research and development work conducted in the past.
- CMR uses personal contamination monitors (Eberline PCM1 and PCM2 and Ludlum 214s) for personal monitoring.
- To enter RCAs, personnel need at least a TLD badge and booties.
- There are very few contaminated areas except glove boxes and facility systems.
- Plastic is laid on the floor to contain contamination, keep it out of the seams between floor tiles, and facilitate cleanup.

**Health Physics/ES&H Aspects, continued**

### 3 Facility Information, continued

- Walls within wings are readily movable for building modifications.
- Health Physics takes random smears from waste material; they do not smear a whole pipe, just representative pieces.
- Everything in an RCA is treated as radioactive waste.
- There is no single, controlled area exit point for waste.

### 4 Radiologically Controlled Areas (RCAs)

- Can the criteria for establishing control zones be improved?
  - Standard guidance for control zones is needed.
  - Implementation needs to be consistent, for example, the use of buffer zones. Some boundaries are fuzzy.
  - Criteria for implementation needs to be discussed.
  - Criteria can help minimize the size of the areas.
- CMR has been experimenting with making the RCA smaller. However, the size of a controlled area creates an operational tradeoff. A smaller area becomes more difficult to work in. Bigger areas are convenient for worker operations, but make it more difficult to control contamination. In a small lab with a hood, do you let the person move freely, or do you have them monitored in and out of a small, roped-off area?
- Revisit controls on materials, equipment, and chemicals - source term entering the RCA.
- Review the selection of materials entering RCAs. For example, could they use metal pallets instead of wood pallets? Investigate what is reusable or recyclable.
- Worker ownership of RCAs
  - Workers do not have a vested interest in waste minimization
  - No performance incentives or disincentives for workers.

### 5 Risk and Perceived Risk

- Perceived risk by members of the public. Any association with radioactivity creates a perception of high risk.
- Zero Risk Mentality. There are two aspects:
  - If LLW ends up in the wrong bin and goes to a public landfill, workers and managers fear the consequences, which may be severe.
- The public is unwilling to accept any risk it cannot control (i.e., individuals are willing to take the risk of driving a car, but are not willing to accept LANL's certification of low level radioactive waste).

**Health Physics/ES&H Aspects, continued**

### 6 Protective Clothing

- The current waste practices for protective clothing are:
  - Throw contaminated anti-Cs in the trash
  - Launder potentially contaminated anti-Cs
  - Launder booties
  - A person working in a low level RCA may wear the same type of clothing as a person working in a glovebox.
- No institutional guidance is provided for protective clothing usage within an RCA vs. a buffer area. **NOTE:** Since this workshop was held, ES&H has issued guidance.
- Potential for using modesty clothing may be present.

### 7 Cost Issues

- Generators do not know the costs for radioactive waste processing and disposal.
- Low or no cost for low level radioactive waste disposal creates an incentive to send all waste to disposal.
- Characterization requirements vary or are ill-defined, which creates a strong potential to increase costs.

### 8 Containers

- Small step-on cans are used for higher-level contamination.
- Phoenix cans (1 ft x 1 ft x 2 ft) are used for LLW.
- Large green boxes used for LLW.
  - Labels tell whether waste is compactible or noncompactible. The label also has a box number, bar codes, and the building designation.
  - Each box has associated paperwork.
  - Personnel survey the whole box, not individual items in the box. Waste generators are working with the waste management group to set up a standard procedure for waste characterization.
- Mixed waste is handled separately, in small quantities.
- TRU waste is stored temporarily in 55-gallon drums.

# APPENDIX B

## Written Questionnaires